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NEW HAMPSHIRE COLLEGE

AGRICULTURAL EXPERIMENT STATION

NINTH ANNUAL REPORT

BY CHARLES S. MURKLAND

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

DURHAM, N. H.

NEW HAMPSHIRE COLLEGE

OF

AGRICULTURE AND THE MECHANIC ARTS

AGRICULTURAL EXPERIMENT STATION

DURHAM, N. H.

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The Bulletins of this Station are sent free to any resident of New Hampshire upon application

NINTH ANNUAL REPORT

The ninth annual report of the New Hampshire College Agricultural Experiment Station, for the year ending November 1, 1897, is hereby respectfully submitted. The reports of the departments will be found upon the pages indicated in the following list:

Financial Statement 117
Report of the Vice-Director 119
The College Herd 120
Department of Agriculture and Horticulture 122
Department of Entomology 138
Department of Bacteriology 146
Department of Meteorology 148

CHARLES S. MURKLAND,
Acting Director.

ANNUAL STATEMENT

Of the Hatch Fund of the New Hampshire College of Agriculture and the Mechanic Arts, for the year ending June 30, 1897.

RECEIPTS

Cash received from United States treasurer . . .	$15,000.00

EXPENDITURES

Cash paid for salaries	$7,378.70	
labor	2,392.36	
publications	787.60	
postage and stationery . .	84.61	
freight and express . . .	172.78	
heat, light, and water . .	519.59	
chemical supplies . . .	67 66	
seeds, plants, and sundries .	201.72	
fertilizers	245.60	

Cash paid for feeding stuffs	$665.59	
library	136.24	
tools, implements, and machinery	780.83	
furniture and fixtures	57.56	
scientific apparatus	168.84	
live stock	496.77	
traveling expenses	125.45	
contingent expenses	1.30	
buildings and repairs	716.80	
	$15,000.00	$15,000.00

SUPPLEMENTARY STATEMENT

RECEIPTS

Cash received from the State Board of Agriculture for analysis of fertilizers, also sundry fees for water analysis,	$1,243.00
Cash received from sales of farm produce	2,029.68
	$3,272.68

EXPENDITURES

Cash paid for salaries	$739.86	
labor	1,172.14	
freight and express	11.20	
chemical supplies	69.02	
seeds, plants, and sundry supplies	157.99	
feeding stuffs	145.46	
tools, implements, and machinery	78.42	
scientific apparatus	46.14	
live stock	698.67	
buildings and repairs	153.78	
	$3,272.68	$3,272.68

REPORT OF THE VICE-DIRECTOR

To Charles S. Murkland, Acting Director:

The work of the experiment station has been continued during the year, closely along the lines described in the last annual report. Its facilities for investigation have been notably increased by the privileges afforded in the new green-house, insectary, and cold-storage cellar constructed by the college from the state's biennial appropriation; and consequently the scope of its experiments for the coming year will be widened.

The station has co-operated with farmers in testing varieties of potatoes, with creameries in settling disputes about milk-testing, with lumbermen in studying the destruction of the spruce forests by insects, and with the State Board of Agriculture in the inspection of commercial fertilizers, the exposure of sales of oleomargarine, and in institute work.

The following bulletins have been published during the year:

No. 41. Potatoes, Varieties, Fertilizers, and Scab. By F. Wm. Rane and Leigh Hunt. Pages 1–14.

No. 42. Tomato Growing in New Hampshire. Notes on Tomato Breeding. By F. Wm. Rane and Leigh Hunt. Pages 15–26.

No. 43. Some Inferior Wood Ashes. By Fred W. Morse. Pages 27–30.

No. 44. The Canker Worm. By Clarence M. Weed. Pages 31–42.

No. 45. Fruit and Potato Diseases. By H. H. Lamson. Pages 43–56.

No. 46. An Experiment with a Steam Drill. Methods of Road Maintenance. By Charles H. Pettee. Pages 57–88.

No. 47. The Strawberry in New Hampshire. By F. Wm. Rane. Pages 89-114.

No. 48. Ninth Annual Report.

The following changes have occurred in the station staff:

On January 15, 1897, Mr. Ruel S. Alden resigned his position as assistant agriculturist and farm superintendent, and the scope of Mr. Leigh Hunt's work was enlarged to include it. Mr. William F. Fiske was appointed assistant entomologist on

March 21, and Mr. Elwin H. Forristall, of the class of 1897, N. H. C., was made farm foreman, on June 10. On the completion of the year, October 30, Mr. Hunt severed his connection with the station.

In the department of chemistry there have been employed temporarily, Messrs. Fred D. Fuller, Ernest B. MacCready, and Charles W. Vickery, their time being principally spent in analyzing fertilizers.

Following this may be found short reports of sundry investigations pursued by the different departments.

THE COLLEGE HERD

The following tabulated statement of the performance of the college dairy herd is presented with the belief that it is a creditable record. But little explanation is deemed necessary. The figures are taken from the daily and weekly records of the barn and creamery. The butter is calculated by the standard formula, butter=1 1-6 fat, instead of the actual weights obtained, since the latter would involve corrections for milk and cream sold. The herd milk was tested weekly by a composite daily sample.

Making no deductions, the herd has been equivalent to 284 milch cows and 51 dry cows for one month, and has produced 145,019 pounds of milk and 7,875 pounds of butter, making the average monthly yield per head for 335 cows, 23.5 pounds of butter and 24 cans of milk, or 282 pounds of butter and 288 cans of milk per year.

The only allowance to which attention is called is the fact that one fifth of the herd's equivalent has consisted of heifers in their first lactation period.

The herd is at present composed of 17 Jerseys, 7 thoroughbreds and ten grades, 6 Ayrshires, 5 Guernseys, 5 Durhams, 3 thoroughbreds and 2 grades, and 2 grade Holsteins.

HERD RECORD FROM NOVEMBER 1, 1896, TO OCTOBER 30, 1897.

Month.	Milch cows.	Dry cows.	Pounds of milk.	Average for milch cow.	Average for herd.	Average fat test.	Pounds of butter.	Remarks.
November....	21	10	7,792	371	251	4.85	440	
December....	19	10	9,975	525	344	4.7	546	Two cows sold.
January.....	23	6	10,748	467	371	4.75	595	
February.....	23	3	10,467	455	403	4.65	568	Three cows sold.
March.....	21	5	12,391	590	476	4.65	672	
April.....	24	2	11,955	498	460	4.85	676	One cow sold and one bought.
May.....	25	0	14,079	563	563	4.8	788	One cow sold.
June.....	24	1	13,855	577	554	4.55	735	
July.....	24	3	12,356	515	458	4.65	670	Two heifers calved.
August.....	23	4	11,024	479	408	4.6	591	Fat test lost, but estimated at 4.6.
September....	25	4	12,646	506	436	4.5	665	Two cows bought.
October.....	32	3	17,731	554	507	4.5	929	Two cows sold and eight bought.

Respectfully submitted,

FRED W. MORSE,

Vice-Director and Chemist.

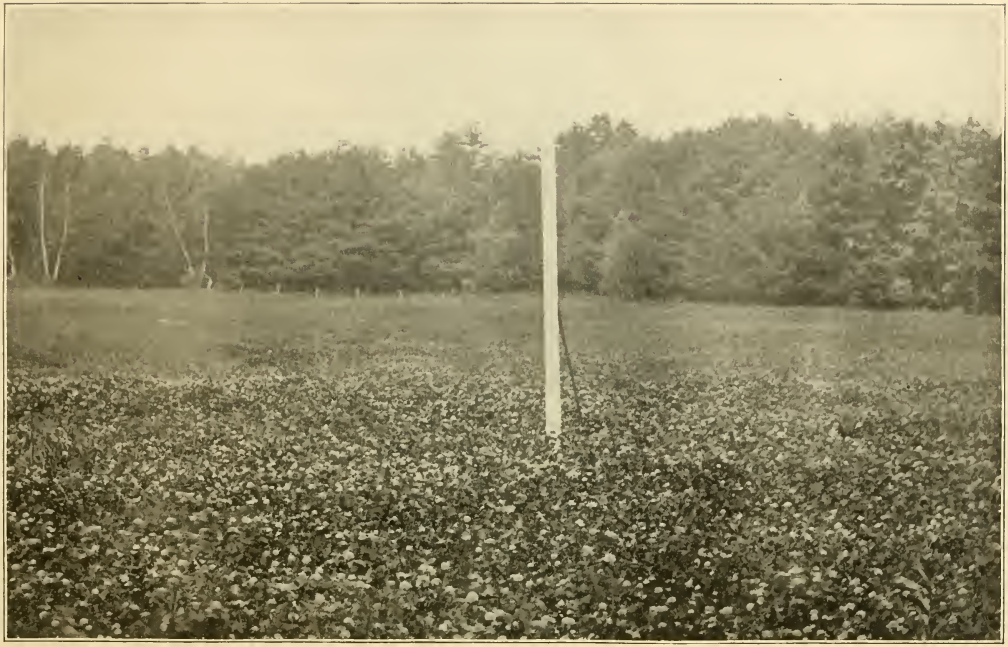


FIG. 1.—Field of Alsike and Red Clover in bloom.

DEPARTMENT OF AGRICULTURE AND HORTICULTURE

AN EXPERIMENT WITH CLOVER

During the past two years the growing of clover has been a success upon the college farm. This crop has been such a discouraging one in the past, and so generally abandoned, we give our method.

The two successful attempts at growing clover have come from spring seeding. One field after having been well manured, using seven cords to the acre of barn-yard manure, and in cultivation for ensilage corn the previous year, was plowed early in the spring of 1896 and fitted; working in during the process, with a cutaway harrow, 640 pounds of commercial fertilizer per acre. The fertilizer used contained the following mixture per acre: 170 pounds dissolved bone black, 170 pounds ground bone, 210 pounds muriate of potash, 45 pounds dried blood, and 45 pounds nitrate of soda.

The other field contained soil similar in every respect to the first, but did not contain a hoed crop the previous season. It was also plowed in the spring of 1896, and stocked, using seven cords of stable manure together with 85 pounds each of ground bone and muriate of potash per acre.

The seed used was three pecks of barley and the following mixture of grass seed, per acre: 5 pounds Alsike clover, 7 pounds choice Red clover, 5 pounds Red-top, and 12 pounds Timothy or herds-grass.

The soil is a heavy clay, but fairly drained, somewhat rolling, and typical of the grass-lands of this section.

Figure 1 represents a field just coming into bloom, which upon close examination shows the clover heads well divided between the Red and Alsike. At cutting time, in some sections of this field, three feet was not an uncommon height.

Figure 2 represents the harvesting of the clover crop during the past season. The average yield from this field was 4 tons, 1,097 pounds per acre. This weight includes both the first and second crops, which were 3 tons, 55 pounds, and 1 ton, 1,042 pounds, respectively.

FIG. 2.—Harvesting Clover on College Farm, 1897.

Two large plots were measured out in each of the fields, representing similar conditions. The field upon which corn had been raised one year, and followed by stocking down with commercial fertilizers, produced at the rate of 4 tons and 835 pounds per acre. The other field, stocked with manure and some fertilizer, gave a yield of 4 tons and 1,360 pounds, the results being slightly in favor of the latter by 525 pounds per acre.

The past season was an exceptionally favorable clover year, barring the unfavorable weather for making hay; however, the preceding winter was rather severe upon newly stocked ground.

The fields seeded during the past season made a very fine showing; the rowen was very heavy, and was cut into the silo in September. When the barley, which was used for the protective crop, was cut for hay, the clover had made an excellent growth, as is shown in Fig. 3, being fully a foot high and very heavy.

POTATOES IN A WET SEASON

When publishing the potato bulletin last year, it will be remembered the Station offered a few potatoes of various varieties for test purposes to any potato growers agreeing to test them and make a report to the Station after harvesting this fall. To this offer the requests were too numerous for our limited supply. Over one hundred lots were sent out, which, as will be seen by consulting the accompanying map, were fairly well distributed over the state.

The season unfortunately having been a very poor one for the crop, we are without the data we had hoped to obtain. Where potatoes were planted on low land they were almost universally reported as complete failures. The average yield was far below what in ordinary seasons would be considered a poor yield. The rot was very prevalent everywhere. At the Station, not only the yield was small, but the potatoes as well.

Reports have been received from over one-half, locations being indicated by the cross (×) on the map, and these have all been gone over to see if any general conclusions could be arrived at. In nearly every consignment, four varieties thought to have merit were included, in order to determine if possible

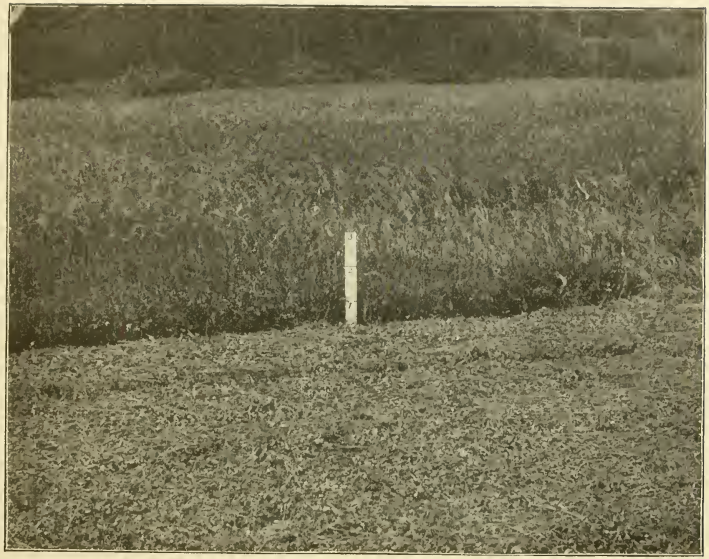


FIG. 3.—Spring Seeding, Clover with Barley, 1897.

the value of each, besides giving an opportunity to compare them under different conditions. These four varieties were, No. 2, American Wonder; 11, Carman No. 3; 57, Quick Crop, and 65, Sir William. They all showed marked superiority in our last year's test here at the Station.

Over fifty per cent. of the reports, where anything like a crop was harvested, give No. 65, Sir William, first place; next come No. 2. American Wonder, and No. 11, Carman No. 3, which stand about even, the former doing better on a loam, while the latter preferred a sandy soil. Quick Crop, while it was not mentioned by any one as giving the highest yield, was credited, beside earliness, with being second best by a great many. Another point very evident was that upon sandy soils the Sir William, with but a single exception, was the poorest.

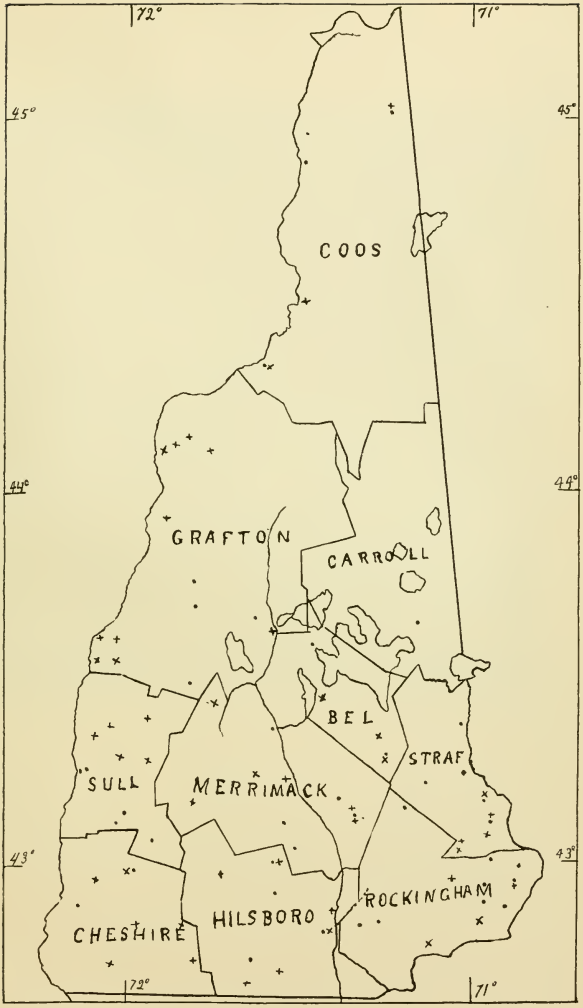
All of the varieties tested last season were again grown this year, together with a number of new ones, making in all ninety-eight varieties. The new varieties under test for the first time were those numbering above eighty. The following table of yield is offered to show how the varieties behave under similar conditions, during a very unfavorable, wet season.

COMPARISON OF VARIETIES OF POTATOES.

(Yield per acre. Calculated from forty-eight feet of row, and thirty inches wide.)

Number.	Variety.	Yield per acre.	Number.	Variety.	Yield per acre.
1	Uncle Sam	202	50	Orphan	19
2	American Wonder	171	51	Parker's Market	216
3	Banner	115	52	Polaris	82
4	Blush	108	53	Peerless, Jr.	135
5	Brownell's Winner	106	54	Prize Taker	75
6	Burpee's Extra Early	108	55	Pride of Ireland	70
7	Burpee's Superior	114	56	Queen of the Valley	83
8	Bill Nye	207	57	Quick Crop	162
9	Bracy's Rising Sun	77	58	Reeve's Rose	188
10	Carman No. 1	280	59	Rochester Rose	73
11	Carman No. 3	25	60	Rupert's Perfection	139
12	Champion	40	61	Rutland Rose	181
13	Clark's No. 1	83	62	Rural New Yorker No. 2	90
14	Clay Rose	198	63	Rose No. 9	252
15	Crown Jewell	97	64	Seneca Beauty	146
16	Country Gentleman	118	65	Sir William	174
17	Delaware	145	66	Somerset	149
18	Dew-drop Rose	144	67	Salzer's World's Fair	96
19	Early Harvest	112	68	Victor Rose	212
20	Early Market	54	69	Vick's Perfection	151
21	Early Norther	70	70	Vaughan	161
22	Early Puritan	97	71	Vick's Advancer	71
23	Early Rose	82	72	White Star	113
24	Early Six Weeks	89	73	White Mountain	171
25	Everitt	47	74	White Rose	206
26	Early Fortune	103	75	Wilson's First Choice	218
27	Early Wisconsin	83	76	Woodhull's Seedling	133
28	Early Thoroughbred	115	77	World's Fair	243
29	Freeman	116	78	Woodbury White	172
30	Farmer's Alliance	92	79	White Ohio	162
31	Good News	103	80	Governor Rush	139
32	Great Divide	50	81	Sir Walter Raleigh	217
33	Green Mountain	89	82	Bovee	203
34	Harbinger	128	83	Pink Eye	122
35	Houlton Rose	73	84	Livingstone	128
36	Harvest Queen	139	85	Early Roberts	214
37	Howe's Premium	104	86	Fill Basket	293
38	Honeoye Rose	.....	87	Buck's Chance	.....
39	Irish Cobbler	96	88	Prolific Rose	264
40	Irish Daisy	36	89	Pride of the South	283
41	King of the Roses	135	90	Early Michigan	199
42	Koshkonong	24	91	Algoma	303
43	Late Puritan	169	92	Alexander Perfection	303
44	Leonard's Favorite	65	93	Burns No. 1	294
45	Maggie Murphy	111	94	Snow Flake	37
46	Money Maker	54	95	Virgirosa	309
47	Mill's Endurance	59	96	King of the Earliest	181
48	New Queen	104	97	North Pole	119
49	Ohio, Jr.	75	98	Mill's Prize	152

Most of the growers have signified their intention of trying the same varieties another season, at the end of which time their notes, together with those of our own, ought to give us a considerable insight into the question of varieties as suited to our conditions. A number of the potato bulletins of last year,



Map showing points in the state where Potato experiments are being conducted.

discussing the varieties then considered, are yet on hand for distribution. The potato crop is well adapted to the state, and the best varieties to grow can be found out in no other way than by making a study of them under favorable conditions.

New Hampshire Fruit Calendar for 1897

Under this head the general subject of fruit-raising in the state may properly come. During the past two seasons a beginning toward a study of the pomological sections of the state has been made. Progress has been slow, although material is gradually coming to hand. We have been unable to get the addresses of fruit growers. A list has been begun, from the names of fair exhibitors and those attending Grange and farmers' institutes, as well as through the correspondence of the horticultural department. In a few years we ought to be able to know just what our fruit interests are. The Experiment Station requests that reports be sent from all who have had any experience in raising fruit of any kind in the state. When writing, please state just what fruit you are growing; also number of trees or area in small fruits as well as your experience with varieties, culture, spraying, etc.

The writer was judge on fruits at two fairs, the Interstate fair held at White River Junction, Vt., and the Merrimack County Grange fair at Warner; also a visitor at the Rochester fair. He has received a full report upon fruits together with specimens from Mr. G. F. Smith, superintendent of the horticultural department of the State Grange fair at Tilton. Notes from these sources, together with those from college students living in various sections, and correspondence as well, form the basis of this calendar.

The Apple.—After the over-abundant crop of 1896, it was not expected that apples would be plentiful this season. While they have been very scarce, the crop has not been a complete failure. Here and there farmers have had a few barrels to sell. Even the poorest apples, such as windfalls and wormy fruit, found a ready market in many towns. The display at the Interstate fair from New Hampshire was very creditable, considering the earliness of the season, August 24–27. The fruit

FIG. 4.—Apples from Meredith.

1 Early Strawberry,
2 Fall Pippin,
3 Fameuse,
4 Red Gilliflower,
5 Holland Pippin,
6 Jewett's Red (Nod-
7 King, [head),
8 Lady Sweeting,
9 Northern Spy,
10 Peck's Pleasant,
11 Roxbury Russet,
12 Seek-no-further,
13 Stark,
14 Twenty Ounce,
15 Yellow Bellflower,
16 Bethel Sweet,
17 N. Y. Sweet Russet.

was immature and not well colored. Five hundred plates were on exhibition, specimens of some of the leading varieties of which are shown in Figure 5. From consultation with some of the leading growers, it was concluded that there was about one third of a crop in this section.

1 Red Astrachan,
2 Yellow Transparent,
3 Early Joe,
4 Early Harvest,
5 Early Harvey,
6 William's Favorite,
7 Porter,
8 Maiden's Blush,
9 Peach of Montreal,
10 Sops of Wine,
11 Wagener,
12 Emp. of Alexander,
13 Juneating,
14 Bethel,
15 Sweet Russet,
16 Wealthy,
17 McIntosh Red,
18 St. Lawrence,
19 Fall Pippin,
20 King,
21 Hubbardston,
22 Nodhead,
23 Ben Davis,
24 Scott's Winter,
25 Yellow Bellflower,
26 Dexter,
27 Blue Pearmain,
28 Swaar,
29 Munson's Sweet,
30 Pound Sweet,
31 Lady Sweeting,
32 Westfield Seek-no-fur-
33 R. I. Greening, [ther,
34 Tallman Sweeting,
35 Northern Spy,
36 Baldwin,
37 Roxbury Russet,
38 Fameuse.

At Tilton, Mr. Smith reports 850 plates of fruit as compared with 1,000 last year. The fruit was lacking in both size and quality, although there were many exceptions. Figure 4 represents a specimen of a few varieties from Mr. Smith's own place this season.

The apples at the Rochester fair were very imperfect, taking them as a whole. The number of varieties was quite representative but the fruit inferior, showing that it was impossible to secure average specimens for exhibition according to report. Not many new orchards were set. It is feared that too many rely upon trees far past their usefulness for a paying crop.

The Pear.—The season of 1897 has been to the pear what that of 1896 was for the apple. The exhibits at the fairs named were all of high standard, and contained many varieties. At Tilton, Mr. Smith says, "The exhibition of pears was equal, if not superior, to anything ever made in New Hampshire." Figure 6 contains a representation of fourteen varieties from the central part of the state.

The Peach.—The peach is grown in some sections of the state with success. The past season has been a peach year in New Hampshire. While it is true that there are not many

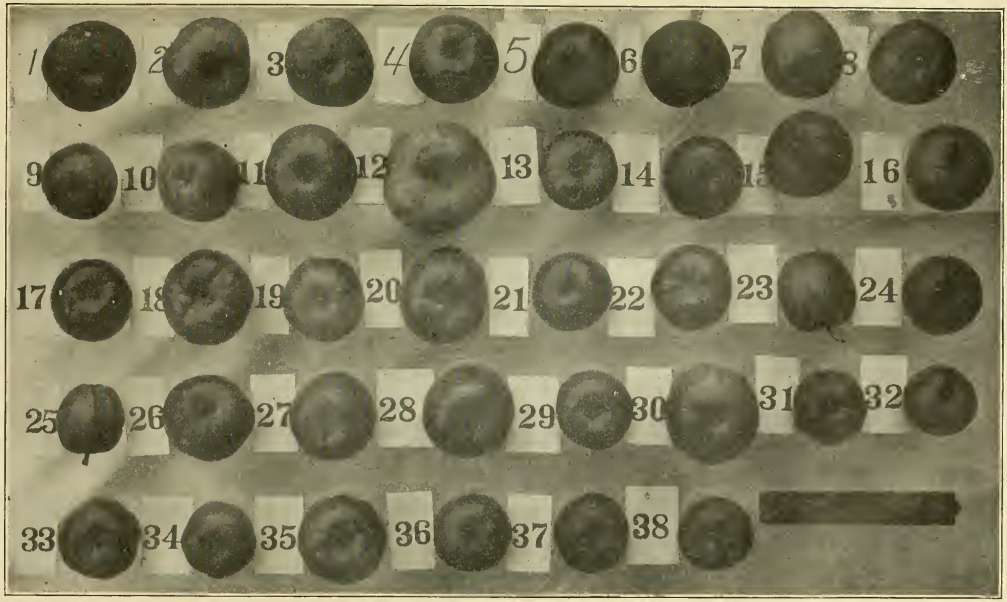


FIG. 5.—Apples from the Inter-State Fair.

extensive orchards, there seems to be an inclination toward growing more peaches. Several have set orchards this season. Nearly all trees bore fruit this year, even those very old and neglected. At the fairs the exhibits were exceptionally good, leaving out, perhaps, the display at Tilton; but even here one man, Mr. C. E. Pillsbury of Londonderry, exhibited twenty plates.

Upon invitation from Mr. Charles M. Stratton of Hollis, his peach orchard was visited on September 6, at which time he was picking and marketing his Mountain Rose fruit. A finer crop was never seen by the writer, even in the famous belts of Delaware or Western Michigan. His main orchard, which had been set but five years, contained 475 trees and has produced about 900 baskets of one-half bushel each. It was all marketed in Nashua and handled by one groceryman as fancy fruit. His other variety was the Early Crawford, which is a trifle later and equally as productive. A number of photographs were taken of the orchard, together with full notes upon his method of cultivation, etc., which together with notes from other sources will be published when sufficient material has been collected to warrant a bulletin on the peach. An excellent report was also received from Mr. G. S. Tuttle of Barrington, who has 1,500 peach trees representing numerous varieties, but he reports no crop this season. He says there are a few trees on his place that were set about forty-one years ago, which fact shows that the peach tree must be hardy in New Hampshire. To get the most out of peaches we believe they should be set often, thus using them more as a rotation on land. A few old trees, however, owned by Major Mellen of Durham produced a very heavy crop. These trees stand at least twenty-five feet high.

The Plum.—Reports from various sections regarding this fruit differ widely. In 1896 there was a very heavy crop in the section of Lake Winnipesaukee; at the State Grange fair, Mr. G. F. Smith of Meredith had on exhibition twenty-two varieties. Specimens of thirteen of these varieties are shown in Figure 7. This year there were no plums in this section. On the other hand, Mr. F. B. Hanchett of Plainfield and John Gould of West Lebanon report remarkably heavy crops. Re-

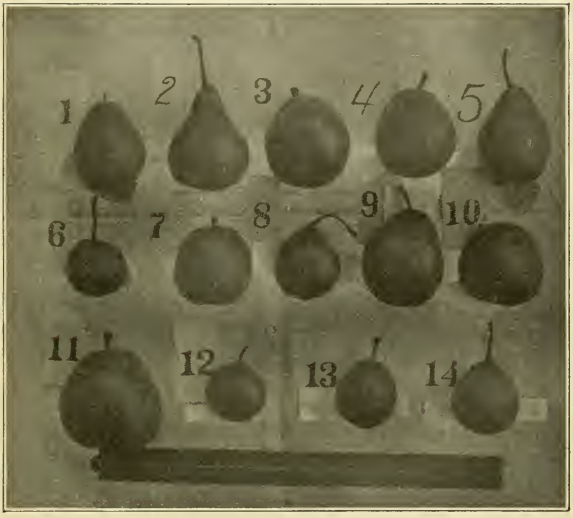


FIG. 6.—Pears from the central part of the state.

1 Lawrence,
2 Beurrè Bosc,
3 Beurrè d'Anjou,
4 Dovenné Boussock,
5 Louise Bonne of Jersey,
6 Winter Nelis,
7 Sheldon,
8 Tyson,
9 Bartlett,
10 Fulton,
11 Duchesse,
12 Seckel,
13 Buffum,
14 Belle Lucrative.

ports have also come from many plum raisers about Nashua, indicating a generally good yield throughout this section. The Lombard variety seems to be the general favorite. No reports have been received from elsewhere in the state. The Experiment Station has a young orchard which was set in the spring of 1896 containing a single specimen of thirty-five varieties. We expect to make additions from time to time. The plum, we believe, deserves more recognition as a fruit well adapted to our conditions.

Cherries.—It has been impossible to get any accurate idea of the cherry crop. Wherever seen they brought a good price. The common sour cherries brought 12½ cents per quart in this section of the state and there was a very limited supply. On July 5, the native sweet cherries were bringing 17 cents to 20 cents per pound upon the Portsmouth market, when the California fruit was only 25 cents per pound. I have yet to know of any of the Russian varieties of cherries being tried in the state. Cherries certainly should be made a success here. The failures of late are doubtless due to insects, and fungous diseases, which should be easily overcome. The Experiment Station intends to set out an orchard this spring.

Small Fruits.—The strawberry has already been considered in Bulletin No. 47 of last month, and the reader is referred to it for this fruit. Raspberries, both the red and black-cap varieties, do not seem to be grown under domestication to any great extent. Most of the fruit offered in many sections is that from the wild or native bushes, which cost only the time in picking. There was a fair crop of this fruit this season, and the demand was very good. It is understood that where this fruit is grown for market there is little trouble from the competition of the native fruit, even at higher prices. Blackberries, like raspberries, are found growing wild throughout most sections of the state. The crop this season was a heavy one, but, due to such a wet season, were watery and did not possess their usual flavor. The wild fruit doubtless affects the market for cultivated varieties, unless it is in the larger cities where a taste has been cultivated for the latter. Currants were very plentiful late in the season, but earlier they seemed to be very scarce. All bushes, even those which have had a bitter

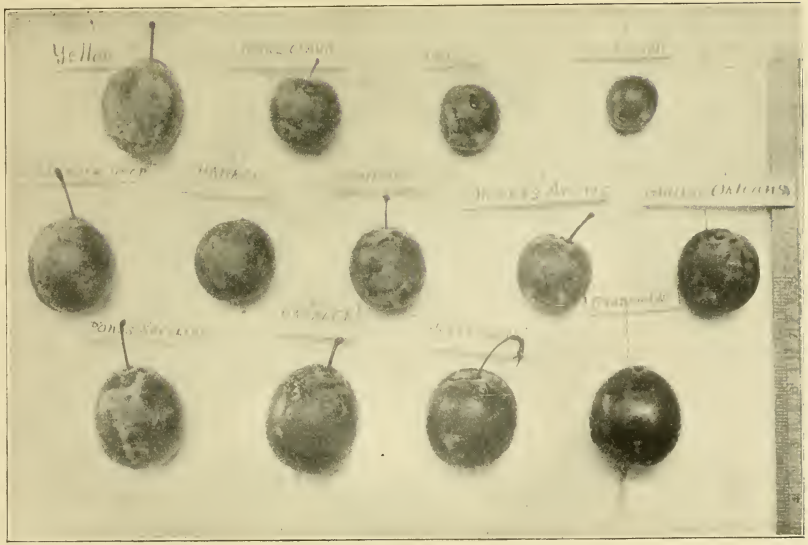


FIG. 7.—Plums from central part of New Hampshire.

struggle for existence, were loaded. Mr. A. M. Cluff of Greenland set 2,133 Fay currant bushes the past season. Gooseberries were very scarce and we have yet to know of any in the state. At the prices asked in Dover, 12½ cents, they could be made a very profitable crop. Cranberries were exhibited at the fairs, most of which were very fine. The Station desires information from those attempting cranberry culture.

F. Wm. Rane,
Agriculturist and Horticulturist.

DEPARTMENT OF ENTOMOLOGY

The entomological department of the Station has been able to accomplish much more work during the season now closing, than during any previous year. This has been largely due to the appointment of an assistant, Mr. W. F. Fiske, so that it has been possible to make continuous observations upon the life-histories of injurious insects—a condition necessary to any adequate success in entomological investigations. Studies of a considerable number of insects have been made, although the major part of the assistant's time has been spent in increasing and arranging the insect collections which form, perhaps, the most essential portion of the equipment of the department. The number of insects in the collection has been doubled during the year, more than 5,000 specimens having been added. The card index to entomological literature has also been much increased, and the general facilities for the carrying on of the work have been improved.

The insectary has been found useful in studying the life-histories of insects, and its utility is likely to increase as the scope of the work undertaken enlarges.

Fig. 1. Rose leaf eaten by Tent Caterpillars. (Original.)

I desire here to express my thanks to Dr. L. O. Howard and the entomologists associated with him in the Entomological Division of the United States Department of Agriculture, for the determination of many insects during the year. The assistance thus rendered has always been prompt and courteous, and has been of great value in our work. It deserves the fuller acknowledgment, because it is seldom practicable to render adequate return for the favors so freely given.

The Insect Record for 1897

The ravages of the common Tent Caterpillar continued during the early part of the season to very much the same extent as last year. We followed the history of the insects, carefully noting their range of food-plants and times of transformations, and began a systematic study of the natural enemies of the pest. We hope to continue this investigation through the coming season. Already we have bred more than twenty different species of primary and secondary parisites from these tent caterpillars, which fortunately are subject to such enemies from the time they are in the egg until they become full grown. These studies have served again to show how intricate are the

arrangements by which the increase and decrease of noxious insects are regulated.

The extending range of food-plants mentioned in my previous reports upon the tent caterpillar was as much in evidence this season as before. Mr. Fiske, who was instructed to make special observations upon this phase of the subject, has summarized his notes as follows: The list of food-plants of the American tent caterpillar is long and varied, and when compared with other caterpillars, a peculiar fact is noticeable. In most cases where the food is varied, the insects confine themselves to certain orders of plants, usually nearly related to each other, but the prime requisite with the present species seems to be that the plants shall be of a shrubby nature. The members of the rose family seem to be the natural food of the tent caterpillar, and very few, if any, of the shrubby and arboreal members of this family escaped. All species of plum, pear, and apple (the genera *Prunus* and *Pyrus*) seem to be used for the deposition of eggs, although the two common wild cherries, the black cherry and the choke cherry, and the apple are most commonly chosen. The egg-masses are seldom deposited upon roses, although the caterpillars attack the leaves readily (Fig. 1). The herbaceous members of the family are, however, let severely alone, and even the shrubby dewberries, raspberries, and blackberries (of the genus *Rubus*) are seldom touched. The woody spiraeas or hardhacks are fed upon, especially the white hardhack. Outside the rose family I have seen original colonies (that is, colonies from egg-masses deposited on the plant), on species of but few families. Perhaps

Fig. 2. Poplar leaf eaten by Tent Caterpillars. (Original.)

the most common of these belong to the willow family, the leaves of all species of willow and poplar (Fig. 2) being eagerly devoured. Original colonies are also frequently found upon species of the oak family, the birch being, in fact, one of the more common food-plants, while the oak (Fig. 3), hazel, and alder form no slight item in the bill of fare. The only other orders on which original colonies were found were the barberry and dogwood families. Colonies with egg-masses occurred commonly on barberry bushes, and a single tent with the egg-mass was once found on a species of Cornell.

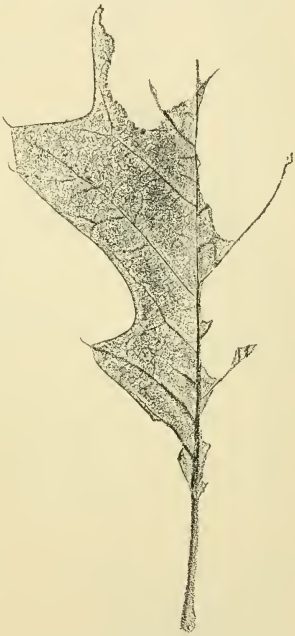


Fig. 3. Oak leaf eaten by Tent Caterpillars. (Original.)

The secondary food-plants were much more varied; it did not seem to make so much difference what they were so long as they were of a woody nature. Maple, locust, currant, witch hazel, viburnum, and blueberry are all attacked, and each belongs to a different family. The only case of an herbaceous diet found was that of a caterpillar in the midst of a field, feeding on the common ox-eye daisy.

The parasites of the tent caterpillar, as already indicated, include many species. The four-winged flies of the genus *Pimpla*—one of the many groups of ichneumon flies—are among the most important of these. The several stages of life of a *Pimpla* parasite are shown in Fig. 4, which was drawn under the writer's direction, when he was connected with the Ohio Experiment Station, and is here used by courtesy of the

officers of that station. The egg is shown at *a*; the larva at *b*; the pupa at *c*; and the adult at *d*. These figures were made from the parasite as it preys upon the larva of a borer in

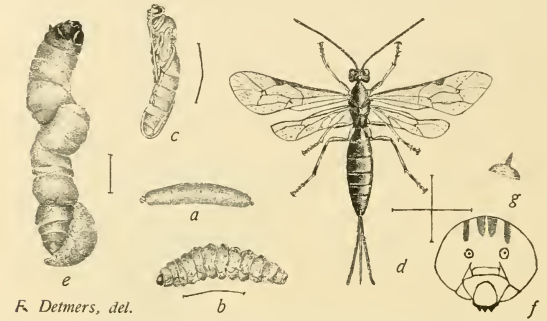


Fig. 4. Life stages of a Pimpla Parasite. (By the courtesy of the Ohio Experiment Station.)

the stems of the evening primrose[1] in which case the parasitic grub feeds externally on its host as shown at *e*. The most abundant species of *Pimpla*,[2] however, as a parasite of the tent caterpillar lives inside the host, which generally is not killed until after it has spun its cocoon.

In addition to the very general attack of the common tent caterpillar, there have been in many parts of the state more dangerous outbreaks of the FOREST TENT CATERPILLAR.[3] This

Fig. 5. Moths of Forest Tent Caterpillar: *a*, Male; *b*, Female. Natural size. (Original.)

insect has been known for many years to become destructive at intervals to a great variety of trees. Its outbreaks are more periodic than those of the common species, and, while they

[1] *Oenothera biennis.* [2] *Pimpla conquisitor.* [3] *Clisiosampa disstria.*

last, generally result in much greater damage. The life-history of both species is quite similar, the chief difference being that the eggs of the forest caterpillars have no protective covering, and that for most of their lives these make no protecting tent, feeding in colonies, however, and crowding together when not eating. Spraying with Paris green when the caterpillars are young is, perhaps, the best general remedy, although, of course, this is impracticable in many cases on forest lands.

There is generally a noticeable difference between the cocoons of the forest tent caterpillars and the common species, the first named having a great deal of loose silk around the outside of the cocoon when it is not spun within the shelter of a leaf. It seems, however, that a leaf is generally used as the outer covering when the insects are numerous on forest trees. A maple grove of several acres at Jefferson, New Hampshire, was stripped of its foliage by these caterpillars, the cocoons being made by sewing the leaves together as represented in Fig. 6. The specimen from which the drawing was made was sent me through the courtesy of Mr. Samuel D. Davis. This forest tent caterpillar has seldom been destructive in New Hampshire heretofore. We are trying to learn its full life-history and hope to issue a bulletin concerning it next season.

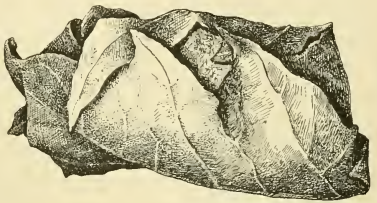


Fig. 6. Cocoon of Forest Tent Caterpillar. Natural Size. (Original.)

The Canker Worm, which was discussed at some length in Bulletin 44, issued by this station last April, has continued to do damage to orchards in certain localities, but in regions where the pests were destroyed by spraying in 1895 or 1896 the outbreak appears to have been satisfactorily checked. Specimens of the fall canker worm moth[1] were sent to me from Hanover, November 3, 1897, with the statement that they had "been very common for the last few days, flying into the halls in the evening, apparently attracted by the electric lights."

[1] *Anisopteryx pometaria.*

This indicates that the pest is again on the increase there, so that it will be well to protect the noble elms which add so much to the charm of this beautiful village.

The small crop of apples, as was to be expected, was seriously damaged by the Apple Worms—the young of the Codling Moth. It is in place here to mention the recent observations of several entomologists—notably Messrs. Washburn of Oregon, Slingerland of New York, and Card of Nebraska—showing that the eggs of this insect are frequently laid upon the *leaves* of apple trees, instead of wholly upon the fruit as heretofore supposed. From an economic point of view this renders more evident the advantage of spraying with Paris green or London purple, so commonly practised by commercial orchardists.

Our observations in many parts of the state, as well as reports from correspondents, show that the Oyster-shell Bark-louse continues to do serious damage in young apple orchards. Its depredations are the more to be feared because the presence of the pest is so frequently overlooked. The scales are the color of the bark, to which they closely adhere so that unless attention is called to them, they are likely to escape notice until they become excessively numerous. Young orchards should be frequently examined; if on the bark of the trunk, branches, or twigs, brown scales the shape of miniature oyster shells are seen, you may be pretty sure that the trees are infested with the oyster-shell bark-louse.

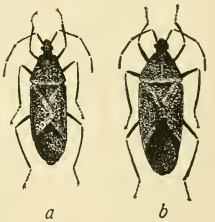
If one of these scales be removed and its lower surface looked at through a lens, a number of small, whitish, oval eggs will be found. These hatch early in summer into tiny insects that wander over the bark and foliage for a few days. They may be seen in June as microscopic whitish specks upon the trees. When thus newly hatched they are easily destroyed by spraying the trees with dilute kerosene emulsion.

I have seen no indication as yet that the dreaded San José Scale, which is causing so much consternation among fruit growers to the south and west of us, has obtained a foothold in New Hampshire. There are reasons for hoping that this pest will not thrive so far north as we are, but it seems advisable that those who plant young trees or shrubs from nurseries out-

side the state should look them over carefully for the small, round scales bordered with a reddish ring. In case such are found, it would be a favor to all concerned to send specimens to the Experiment Station for examination.

Fig. 7. Squash Bug: stage before adult. Natural size. (Original.)

Among the garden insects the Squash Bug[1] has continued to be a troublesome pest. The adult bugs are ready for the tender plants as soon as they appear above ground, inserting their beaks and soon destroying the plant. We have studied the pest both out of doors and in the insectary, but as yet can suggest no better remedy than that of placing shingles or pieces of boards beside the hills; the bugs will congregate under these and by a daily inspection early in the morning, they are readily found and destroyed. By thus killing off the brood that has passed the winter, much of the later damage commonly done by the progeny of these bugs will be prevented. It is well known that the brown eggs are deposited upon the under surfaces of the squash leaves, and that the young which hatch from these soon cause the death of much of the foliage. Consequently it is important to destroy as many of the egg-laying brood as possible.



a *b*

Fig. 8. Squash Bug: *a*, male; *b*, female. Natural size. (Original.)

During recent years much damage to the timber interests of the state has been done by insects. Perhaps the most notable injury has been that to spruce forests by certain small bark-boring beetles. This subject has been studied by us to a considerable extent during the season, and we hope to continue the investigation during next year. We also have begun a systematic study of the bumble bees of the state in the hope of rendering the setting of clover seed, as well as squashes and pumpkins, more certain.

Clarence M. Weed,
Entomologist.

[1] *Anasa tristis.*

DEPARTMENT OF BACTERIOLOGY

The details and results of experiments in treatment of plant diseases during the season of 1896 have been published in Bulletin No. 45.

The following experiments have been carried on during the time covered by this report. It being the non-bearing year the experiments in the treatment of the diseases of the apple in 1897 were limited, being directed to the disease of the foliage known as *Phyllosticta pirini* or leaf spot. As in previous years the Bordeaux mixture has seemed to have but little effect on this disease. During the last three years the apple scab has done comparatively little damage either to the foliage or fruit.

Quince trees were sprayed for the prevention of fungous diseases. Orange rust, which is very common in this vicinity, seems to be but little affected by the treatment. Black rot was so trifling in amount, on even the unsprayed trees, that no conclusions could be drawn. A disease of the foliage, whose identity has not been determined, was largely prevented by the spraying.

Experiments in spraying with Bordeaux mixture against black knot were begun. As the station plum orchard is small and the trees young, they were all sprayed during the time when infection by the summer spores was likely to take place. For the purpose of comparing the development of knots on sprayed and unsprayed trees, a hedge row of choke cherries was made the subject of the experiment. The result of the treatment will not be apparent until spring, when the new knots make their first appearance.

A substance known as Ceres-pulver was sent to the station for trial as a preventative of smut in oats and barley. It is to be applied by soaking the seed in a solution of it. In our trials there was little smut in any of the grain, but rather less where the seed was treated with Ceres-pulver.

Experiments on potato scab were continued on the following lines: effect of different fertilizers, stable manure, phosphate, ashes, lime, kainit, on the development of the disease, effect of treatment with corrosive sublimate, formaline, and sulphur as

preventatives. Experiments in the treatment of the early and late blight of potatoes were continued.

Experiments in dairy bacteriology were carried on as time would permit.

The plants belonging to the natural order Leguminosæ or the pulse family, such as peas, beans, clover, etc., have on their roots, little structures known as root tubercles, which are caused by and contain bacteria-like organisms which are believed to enable the plant in some way to make use of atmospheric nitrogen as food. Cultures of these organisms are now on the market to be used for the inoculation of soil on which any of the legumes are to be grown with the purpose of increasing the number of root tubercles and consequently the assimilation of nitrogen.

A culture, called *Nitragin*, of the organism to be used for peas was sent to the station for trial. This was tried together with crushed tubercles from growing peas. The result in one case seemed to be in favor of the treated plots, and especially that treated with the crushed pea tubercles. The culture was, however, so old when used, and the trial on so small a scale that farther trial is necessary before results can be considered of value. The subject seems to be an interesting and profitable one for investigation.

Caustic potash as a means of preventing the development of the horns of calves has been used with success. The details of the experiments will be published in a forthcoming bulletin on dehorning.

H. H. Lamson,

Bacteriologist.

DEPARTMENT OF METEOROLGY AND AGRICULTURAL ENGINEERING, 1896-'97

I. Meteorology

Observations have been continued the past year as heretofore under the charge of James A. Foord, New Hampshire College, class of '98. During July and August of 1896 the work was performed by Arthur Given, also of the class of '98.

Signal flags have been displayed each day, from 11 a. m. till sunset, indicative of the weather for the following day.

The weather for the year has been characterized by an excessive precipitation; nearly ten inches above the normal. No single month has shown a marked deficiency; the least number of rainy days reported in any one being five, as compared with two the year previous. We seem to be passing through a series of years with large and well distributed rainfall, possibly culminating the past year. The ground has kept well filled with water, springs have yielded abundantly, and the surface has rarely lacked moisture.

The snow fall for the year was small; about the same as the previous winter, and much less than the normal. No snow of any account fell till January 21, and the total for March was small, thus cutting off the supply at both ends. The heavy rainfall of January, February, and March was accompanied, as was to be expected, by a higher average temperature than for either the preceding year or any normal one. A small precipitation kept the temperature of December down to a lower point than in 1895, it being almost as cold on the average as January, which was naturally the coldest of the year.

Specially high water and floods were occasioned by the excessive rainfalls of September 6, 1896, and June 10, 1897. In the latter case 6¾ inches fell within twenty-four hours and most of this within twelve hours.

The summer months of 1896 were on the whole quite normal. Only one sustained heated spell occurred in July and one

in August. The former was of average duration and intensity; the latter of average duration but of exceptional severity.

Frosts held off remarkably in the fall. The first to do serious damage occurred September 24th, while the first absolutely killing one was delayed until October 10th.

The detailed record of observations taken, together with a summary of the same, will be found appended in the special edition of this bulletin, which may be obtained upon application.

II. Agricultural Engineering

During the year this department has made surveys for drainage purposes over a small portion of the black swamp field, and for straightening brooks at three different points on the college farm.

Much labor has been involved in the problem of establishing proper bounds for the highway in front of college property. Such bounds have been located and marked by permanent stone posts on both sides of the turnpike from the top of Spinney hill to the corner east of the president's house, leaving a full width of four rods for the highway the whole distance. These bounds have been assented to by the selectmen, and full records with map have been placed upon the town books. The work of establishing other bounds has been partly done and the same will be prosecuted as time allows.

During the year the steam drill, which had been previously loaned to the institution, has been purchased at a very satisfactory price and added to the college road equipment. It was used in July of 1897, to assist the highway agents of Durham in cutting down the grade of a public way, and proved its utility beyond question. Bulletin 46 has been issued, giving a full account of the work of the preceding year with the steam drill, and also treating of methods of road maintenance in Durham and elsewhere.

Popular talks on road construction and maintenance have been given on numerous occasions during the year.

C. H. Pettee,
Meteorologist.

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